

Delaware Space Grant Consortium  
University of Delaware  
Dr. Dermott J. Mullan  
302-831-2170  
www.delspace.org  
NNX10AN63H

### **PROGRAM DESCRIPTION**

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Delaware Space Grant Consortium is a Program Grant and Capability Enhancement Consortium funded at a level of \$430,000 for fiscal year 2011.

### **PROGRAM GOALS**

Utilize NASA funds to serve students and teachers in the State of Delaware in a variety of educational and training projects in areas which are related to STEM-G. At the college level, provide fellowships and scholarships to students attending 2-year and 4-year colleges throughout the State and to aid in professional development of STEM-G related educators. Enhance research opportunities on and off-campus, during the academic year and summer. Recruit and provide support for the education and training of professionals especially women, underrepresented minorities, and persons with disabilities for careers in fields which will meet NASA's needs in the 21<sup>st</sup> century.

As an indication of the program goals which have been achieved, we may cite results from our Longitudinal Tracking: the percentage of students who have been successfully tracked through their next career step versus their last year of SG support, we can report that this percentage is 80% for 2006 and 100% for 2007, 2008, 2009, and 2010. Figures are not available yet for 2011: all participants are still enrolled.

### **PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, OR 3)**

(1) As regards graduate students, one of the DESGC graduate fellows in FY11 (James Dalessio) provided literally world-wide publicity for Delaware when he led the efforts of the Whole Earth Telescope (WET) in an observing campaign to study pulsations in certain stars. WET consists of astronomers at 29 observatories around the world who agree to observe a certain target for two weeks with as near to unbroken coverage as possible:

when the star sets below the horizon as seen by one observatory, other observatories can still observe the star. Bringing together observations from all observers so that a complete analysis of the star's variations can be performed requires a special set of analysis tools. Mr. Dalessio has developed those tools (in software which he dubs MAESTRO), and for the first time, the campaign in FY11 was analyzed using his package, and under his direct leadership. It is remarkable that a person as young as Mr. Dalessio has the respect of so many observers around the world that they entrust him with the analysis of data from around the world. (Outcome 1) In view of Delaware's claim to being "The First State", Mr. Dalessio's success with reaching around the world allows us to paraphrase a common slogan to become "the First State heard around the world".

(2) As a follow-on to support for attendance at Rock-On rocket launches in earlier years, DESGC in FY11 provided funds for one faculty member and two students from the Terry (Dover) campus of Delaware's two-year Technical and Community College (DTCC) to attend the Academic High Altitude Conference at Iowa State University. There, they learned to build a micro-payload to be flown in a high-altitude balloon. This was a new effort for DTCC. (Outcome 2)

(3) Terence Blanch, a science teacher at Pencader Business and Finance Charter School and at Wilmington University, first came to the attention of DESGC with a tuition scholarship in 2007 which allowed him to learn how to use NASA materials and topics in his high school classes. He is an active participant in Dr. Stephanie Wright's outreach program called "Eyes on the Skies" at DASEF's observatory in Smyrna, DE. In 2011, Mr. Blanch attended the Liftoff Summer Institute in Houston, TX during the last shuttle mission for a week of "non-stop professional development". In October 2011, he applied to JPL to be a Solar System Ambassador for DE: he was accepted and is now in training. In November 2011, he applied for the NASA Endeavor Science Teacher Certificate Program: in December, he received a fellowship in the program which will allow him eventually to complete the process of National Board of Professional Teaching Standards certification. As he says: "It will be a lot of work, but my experiences with NASA and DE Space Grant have inspired me to be a teacher who can accomplish great things, just like the group of engineers and technicians who set a man on the Moon". (Outcome 3)

## **PROGRAM ACCOMPLISHMENTS**

### **Administration**

A major change occurred in FY11 when the former DESGC Program Coordinator resigned to take up another position. After a search process, with 24 applicants and interviews with five, Ms. Cathy Cathell was selected as the new Program Coordinator, starting March 1, 2012.

### **Outcome 1**

#### **(1) Graduate Fellowships**

Seven graduate fellowships were awarded in a competitive process in May 2011: these included three fellowships which were funded with augmentation to FY10 funds, and which had been received too late for award in FY10. One award went to Del State U (our HBCU), the remainder to UD (to the departments of Chemical Engineering, Geography,

Mechanical Engineering, Physics and Astronomy). Two awardees were female, one of these was African-American.

In addition, one graduate student (Asia Dowtin: African American female) was supported in Geography as a teacher in training to bring NASA-related material into the classroom. One graduate student (Joe Russell) in Marine Studies was supported through RID funding to Dr. Jennifer Biddle (the funding for Dr. Biddle had been awarded in FY10, but was not spent on Mr. Russell's support until FY11).

**Metric (Number of grad students supported):** In our FY10 base proposal, DESGC had set as a goal full funding for 4.5 graduate fellows plus 0.5 grad students supported by Bartol Research funding. **We exceeded this goal: ++**

**Metric (Diversity, gender):** Of the nine graduate students supported in FY11 by DESGC, three (33%) are female. **We did not satisfy NASA's goal for female representation (40%). -**

**Metric (Diversity, ethnicity):** In FY11, two of our nine grad fellows (22%) are African-American. According to [http://nces.ed.gov/Programs/digest/d09/tables/dt09\\_228.asp](http://nces.ed.gov/Programs/digest/d09/tables/dt09_228.asp), (the most recent year for which race-based statistics of college enrolment could be found on-line), the total percentage of African-American minorities enrolled in DE colleges is 20.2%. **We satisfied this goal. +**

## **(2) Undergraduate Summer Research**

**Metric: DESGC support of summer research on affiliate campuses:** in our FY10 proposal, our goal was to offer DESGC support to eight summer research students on affiliate campuses. **In FY11, we greatly exceeded this goal.** By leveraging with faculty sponsored research funds, DESGC was able to support 20 undergraduates in summer research in FY11. ++

**Metric: Summer research Program at NASA.** In FY10, we proposed that DESGC would support one student in a summer program at a NASA center. **In FY11, we greatly exceeded this goal:** in FY11, three students were funded at NASA centers, one at GSFC, one at Johnson Space Center, and one at Ames Robotic Academy. ++

**Metric (Diversity, gender):** Among the 20 students in FY11 Undergrad Summer Research programs, four (20%) were female. **We did not satisfy NASA's goal of 40% females. -**

**Metric (Diversity, African-Americans):** Among the 20 students in FY11 Undergrad Summer Research, only one (5%) was African-American. **We did not satisfy the goal of reaching the DE state percentage of African-Americans in college (20.2%). -**

A contributing factor to this low number is that students at Del State have access to a large and active University Research Center in the area of Optics: with a large amount of Grant funding at the URC (\$5 million in total), there are many opportunities for undergrads from Del State to get summer research experience without help from DESGC.

### **(3) Research Infrastructure Development**

In this section, we describe (a) the grant of DESGC/RID funds which was awarded in FY11 to Assistant Professor Dr. Chereese Winstead at Del State University. Also discussed in this section is (b) the process of strengthening our research links with NASA centers and (c) strengthening research links with industry.

#### **(a) “Polymer Functionalization of Nanodiamonds”**

Funding from the DESGC furthered our research efforts in the area of polymer functionalized nanodiamonds. Through DESGC support we were able to establish an external user affiliation with the Delaware Biotechnology Institute (DBI) to further our characterization of our synthesized polymer functionalized NDs. Nanodiamonds are a relatively new class of nanomaterials that are difficult to functionalize and studied by only a limited number of research groups. In this work, we created a ND surface of reactive carboxyl and hydroxyl functional groups that were further reacted via polymer functionalization of the nanodiamonds. These mechanisms rely on polymeric hydrogen-bonding, electrostatic, and covalent interactions with the surface reactive nanodiamonds. Through this work, polymer functionalization has been shown to increase the number of surface reactive groups of NDs to enable *in vivo* applications of polymer functionalized nanodiamonds through the binding of proteins or other biomacromolecules. We obtained a TEM image of chitosan modified NDs after successful conjugation of the biomacromolecule to the ND surface (Image obtained at the Delaware Biotechnology Institute). The TEM image reveals uniform distribution of the polymer functionalized ND particles with no evidence of agglomeration. Polymer functionalized NDs were extensively characterized using FTIR, SEM, XRD, and DSC.

The entirety of this work was carried out with the assistance of undergraduate student (Mr. Samuel Jenifer, Junior, Physics), M.S. Candidate Pushpika Katugampola, and Ph.D. Candidate, Kim Milligan, who won a competitive DESGC Graduate Fellowship. All three of these students presented results at the DESGC Annual Research Symposium (April 27, 2012) at UD: Ms. Milligan and Ms. Katugampola gave oral presentations, and Mr. Jenifer had a poster, at which Director Mullan had an opportunity to discuss the results directly with Mr. Jenifer.

This work is to be presented at the American Chemical Society (ACS) Mid Atlantic regional meeting (MARMS) conference May 31-June 2, 2012. Publication of this work is underway for submission to the *Journal of Drug Delivery* with the students listed as co-authors.

***Metric (Diversity, gender):*** of the RID grant(s) awarded by DESGC in FY11, 100% were awarded to females. **We exceeded NASA’s goal of female representation. ++**

***Metric (Diversity, underrepresented minorities):*** of the RID grant(s) from DESGC in FY11, 100% were awarded to African-Americans. **We exceeded NASA’s goal of African-American representation. ++**

#### **(b) Strengthening links with NASA Centers**

***Metric (Goddard):*** In our FY10 proposal, we had proposed to support at least one DESGC student at GSFC. **In FY11, we achieved this goal**, sending one student (Nick

Troup) to GSFC. +

**Metric (Langley):** The goal in FY10 was to have at least one undergrad summer researcher from DE work at Langley. **In FY11, we did not meet this goal.** –

**Metric (Johnson):** We did not plan explicitly in FY10 proposal to have a student at Johnson Space Center. But in FY11, DESGC supported Ravi Sharma, (UD engineering student) to spend the summer at Johnson. *This is the first time that DESGC has funded a student for summer research at Johnson Space Center.* **We exceeded our goal in this category.** +

**Metric (APL):** In FY10, there was no plan to send students to APL. Although the Applied Physics Laboratory (APL) of Johns Hopkins University is not formally a NASA Center, the satellite development and production work which is done there is very similar to what occurs at Goddard. DESGC funded Eric McGinnis to spend the summer of 2011 at APL. He worked with the Flight Software Engineering Group to design, develop, and benchmark an application designed to perform real-time data compression on a space-based platform (the ground version of the Flight Computer on a specific mission). **We exceeded our goal in this category.** +

Remarkably, Mr McGinnis also found time, during the school year, to go on a service trip to Haiti: he developed an English to Creole tutor application to help Haitian women send emails and communicate in English: this story was publicized in the UD campus on-line news service.

### **(c) Strengthening research links with Industry**

**Metric:** We had not planned anything to strengthen the links between DESGC and industry in FY10. But in FY11, when Kate Gurnon (UD Chemical Engineering) won a competitive DESGC Grad Fellowship to study the possibility that shear-thickening fluids (STF) might help protect astronauts from micrometeoroid impacts, ILC Dover (maker of space suits for US astronauts) became interested and established formal contacts with Kate and her advisor (Dr. Norman Wagner). Some months after Kate won her DESGC grad fellowship, Dr. Wagner also won a NASA/EPSCOR award for spacesuit safety studies in the same area. As a result, the links between DESGC and ILC Dover have strengthened significantly in FY11, so much so that for the first time, the Director of Government Business Development at ILC (Phil Spampinato) was invited to present the keynote address at DESGC's Annual Research Symposium (April 27, 2012). **We exceeded our goal in this area.** +

**Metric:** there was no mention of a search for patents in our FY10 proposal. But in FY11, when Joon Park (UD Mechanical Engineering) won a DESGC Grad fellowship for research into micro-aerial vehicles, the possibility of a patent arose. Mr. Park and his advisor, Dr. Agrawal, applied in November 2011 for a US patent on their design of a "flying insect" machine. Once the patent was applied for, Mr. Park was free to report on his work at the Annual Research Symposium (April 2012). However, Director Mullan had been embargoed from reporting on that work at the Mid-Atlantic regional meeting of SG (November 2011: before the patent application was submitted). **We exceeded our**

goal in this area. +

## **Outcome 2: Higher Education**

*(a) DESGC Graduate Student in Teacher Training in Geography.*

**Metric:** In our FY10 proposal, our goal was to provide funding to a graduate student in UD's Geography Department to expand teaching resources (specifically, satellite imagery) for DE classroom teachers in support of DE geography standards. In FY11, this program continued, and Asia Downtin (African-American, female), with advisement from Dr. Margaret Legates, was supported with DESGC higher-ed funding for this task. Asia gave an excellent oral presentation about her work at the Annual Research Symposium April 2012. **We satisfied this metric:** +

*(b) DESGC funding for Community College students in rocket/balloon launch programs.*

**Metric:** In our FY10 proposal, our goal was to provide rocket-launch funding to 2 participants from Delaware's two-year Community College system (DTCC), including one faculty member (Dr. Lester Link, chair of Electronic Technology) and his students. In FY11, funding was provided to Dr. Link and two of his students to attend a High-Altitude balloon workshop at Iowa State University, where they learned how to build a micro-payload to fly to high altitude in a balloon. **We satisfied this goal.** +

*(c) Undergraduate tuition scholarships*

**Metric (Number of awards):** The goal in our FY11 DESGC base proposal was to spend a total of \$7,500 for three students at DTCC (Delaware's Community College) and \$21K for seven awardees at non-DTCC campuses. **We exceeded the metric for the Base Proposal for non-DTCC students:** DESGC in FY11 provided Undergrad Tuition Scholarships to 13 students at non-DTCC schools. ++

But **we did not achieve the metric** for DTCC students: no DTCC students applied, because many students qualify for the DE "seed" program, and do not need DTCC tuition. –

**Metric (Distribution among affiliates):** Of the 13 non-DTCC awardees, two were at Del State (our HBCU), three were at Wesley College, three were at Wilmington University, three were at UD, and two were at our newest affiliate, Goldey Beacom College (GBC). This is the first time that DESGC funds have ever gone to students at GBC. ++

**Metric (Diversity, ethnicity):** The percentage of African-Americans in DE colleges is 20.2%. **We failed to achieve this metric in undergrad tuition awards:** in FY11, of the 13 awardees, only one (8%) was African-American (Justin Davis at Del State). -

**Metric (Diversity, gender):** Of the 13 awardees, six were female, a percentage (46%) which is above NASA's goal (40%). **We exceeded NASA's goal for female awardees in this category.** ++

**Metric (DTCC Diversity):** Our two-year affiliate Delaware Technical and Community College (DTCC), although not officially an MSI, includes a more representative population of underrepresented minorities among the student body on its State-wide

campuses than UD. In FY11, the DESGC goal was to have at least one African American supported with undergraduate tuition scholarships at DTCC. **We failed to achieve this metric. -**

**Metric (DSU Diversity):** The goal for DESGC in FY11 was to have at least one underrepresented minority (African-American) undergrad tuition scholar at Delaware's HBCU. **We satisfied this metric** (Justin Davis). +

**Metric (Wilmington University [WU] Diversity):** The DESGC goal in FY11 was to maintain at least two WU students as undergrad tuition scholars. DESGC actually gave three awards to WU students. **We exceeded this metric.** ++

*(d) Student/faculty access to astronomical observations at a national observatory* The SMARTS project (Small and Moderate Aperture Research Telescope System) invites universities to be members of a consortium which will allow access to four telescopes at Cerro Tololo Interamerican Observatory in Chile. The University of Delaware has been a member of the consortium since 2006, with most of the membership payment (\$70K per year) coming from an endowment with the remainder from grants. In FY11, DESGC contributed \$4K towards SMARTS membership. SMARTS continued to play a major role in the activities of the Delaware Asteroseismic Research Center's (DARC) research activities on pulsating white dwarfs, including both observing runs as part of the Whole Earth Telescope (WET) and independent runs in support of DESGC Grad Fellow James Dalessio's Ph.D. Thesis. SMARTS was also used to observe new nearby very-low-mass stars candidates identified using the new data release from NASA's Wide-field Infrared Survey Explorer (WISE.) This work involved UD graduate student Phil Castro. Finally, UD Prof. Owocki and post-doc Dr. Oksala (a former DESGC Grad Fellow) continued to monitor the spin-down of massive stars, building on the work of Oksala's (2011) Ph.D. thesis.

Support of SMARTS is a new endeavor on the part of DESGC over the past 2-3 years: in FY10, no metric had been established for this. The fact that funds could be made available, and DESGC fellows were able to take advantage of this, is a plus. **We exceeded this metric.** ++

### **Outcome 2: Higher education: pre-college programs**

DESGC Programs which are aimed at professional development of teachers are run by Dr. Stephanie Wright (founder and CEO of the Delaware Aerospace Educational Foundation [DASEF]). Dr. Wright's programs in FY11 were as follows.

**Rocketry Challenges for Teachers:** This Statewide rocketry program is designed to assist teachers as they use rocketry as the unifying theme for teaching STEM and non-traditional career choices, skills and technology. Challenge packages and rocketry curriculum are sent to teachers in all schools in the state of Delaware. This program includes a "teacher self-training" based on the NASA Rocketry Book to teach the Laws of Physics and a "how to guide" to construct the various rockets. Approximately 16 educators from 13 schools and home schools within the State of Delaware and seven

CAP squadron leaders participated in the annual Rockets for Schools program held on May 7 at Cape Henlopen State Park. 120 student and cadets participated. 300 general public were at the event.

**Mentors for Rocket Program:** A segment of the Rocket Program partners with undergraduates in the Mechanical Engineering Department at the University of Delaware where they worked with and mentored students in learning the Laws of Physics as they built and launched rockets. The ME students shared their reasons for entering the field of engineering and served as role models to the younger students. This is an annual program coordinated by the ASME at the University of Delaware. The DESGC assisted with funding for materials, rockets and room rental.

**Science, Math, Engineering and Technology Curriculum for Teachers:** This program is designed to assist teachers as they use STEM curriculum in their classrooms during the school year. STEM Curriculum is distributed to participating teachers in Delaware. This program includes a "teacher self-training" based on the NASA materials and curriculum handbooks that focus on specific STEM materials. Approximately 62 educators from 28 schools within the State of Delaware participated in the program. All teachers accompanying field trips are given teacher packets containing NASA materials.

**Delaware Aerospace Academy:** In operation every summer since 1990, the objective of the Delaware Aerospace Academy is to provide hands-on training and experiences through our Destination academies in related activities and fields. Throughout the week-long program (which is repeated for different sets of students), students in grades 1 - 10 are challenged to think, create, solve, build, and work cooperatively. Curriculum used in the academies is standards based and designed to integrate the study of STEM using Earth and Space Education as the unifying framework. Current STEM/NASA themes and content are integrated into the curriculum and participants and staff are informed of current NASA opportunities, mission activities programs and opportunities throughout the year. In 2011, 14 teachers and undergraduates were mentored in the process of supervising 250 students in attendance.

**Professional Development Workshop (February 23):**

During this session, educators looked back at the Earth and out into the Universe. They experienced the StarLab, observed the stars in the Mountjoy Observatory using DASEF's 16" Meade Telescope. Each educator constructed their own Galileoscope telescope and viewed the constellations and planets. NASA materials and resources were distributed.

**Earth Systems Workshop (May 16):** A 3-hour evening program for K-8 teachers at DASEF's Environmental Outpost in Smyrna, DE, included instruction in remote sensing of the Earth, and introduction to DASEF's Planet Earth Outreach program.

**The SunWise Program Workshop (October 7):** A 7-hour program for Science/technology teachers of K-8 grades at the Environmental Outpost in Smyrna, DE. SunWise is a national award-winning environmental and health education program to teach children and their caregivers how to protect themselves from overexposure to the



sun. SunWise is the only national K-8 skin cancer prevention program in the United States. Program features are designed to raise awareness of stratospheric ozone depletion, foster awareness of the need to protect one's skin and eyes from excessive sun exposure, and deliver accurate, timely, and useful UV data to schools and communities for use in day-to-day decisions regarding personal sun safety. Each school receives a free SunWise Tool Kit with standards-based, cross-curricular classroom activities for grades K-8; a UV sensitive Frisbee for hands-on experiments and fun; story and activity books; a poster; a video; policy guidance, and more.

### **Outcome 3: Informal Education**

DESFGC offers the following informal education opportunities to engage and inspire.

**Goddard Space Flight Center Forum (March 17):** Dr. Stephanie Wright led a one-day trip for 23 DE teachers to GSFC to tour GSFC, and hear NASA speakers describe NASA projects.

**National Air and Space Museum (March 19):** Dr. Stephanie Wright led a one-day visit to NASM for teachers of K-12 students.

**Terence Blanch:** as mentioned above, former DESGC tuition awardee Blanch has become actively involved in helping Dr. Wright with her outreach programs. It was a recommendation from Dr. Wright that caused DESGC to fund Mr. Blanch's participation in the week-long Liftoff Summer Institute in Houston, TX during summer 2011.

Also, funding from DESGC enabled Mr. Blanch to purchase an iOptron Minitower Protelescope mount. He reports: "This telescope mount has been used at several venues and has offered views of the sun, moon, and stars to students of all ages. It has been used extensively at the DASEF 'Eyes on the Skies' program. The mount's capacities in both load carrying and object location have made it a superior tool for astronomy education and outreach. One spectacular night at DASEF, I was fumbling without my glasses to read the hand controller display and asked an interested young man to be my assistant. He followed along, entered the numbers in the proper boxes and hit enter. Off the telescope went slewing to the target in it unusual manner. When it stopped, I asked him to see if it had found the target. He checked and it had, so I asked him to show everyone else. He was a great helper and found many objects that clear night. We even were able to see M57 at the meridian. On another clear sky night, a group of students from St. Elizabeth's High School (in Wilmington DE) used the mount to slew an eight inch SCT to objects all over the sky. That night the students were able to locate the ET cluster (NGC 457), the double cluster (NGC 884), Venus and Jupiter. The students enjoyed pressing the buttons and were concerned that they would break something. This mount has allowed me to spend more time talking about objects instead of trying to locate objects. It has allowed me to take images with video cameras to use in the classroom. It is easy to carry, easy to set up and easy to align. Overall it is an excellent interface between people and the stars".

From the style of the previous paragraph, it is easy to see why DESGC appreciates the enthusiasm which Mr. Blanch brings to his "work".

**Science fair judging:** In order to encourage STEM studies among Delaware students, Director Mullan has served, for each of the past 5 years, as a Judge at a Science Fair at a private school (Aquinas Academy) in Bear, DE. As a member of a panel of 4-5 judges, Mullan evaluates and ranks the projects from the students in the highest grades (10-12).

**Science at College Commencement:** Director Mullan was invited to be Commencement Speaker at Mater Ecclesiae College, Greenville, RI, which offers BA degrees in pastoral religious activity. Although STEM topics are only a minor part of the curriculum, Mullan used the opportunity to instruct the graduating seniors about a physics process on which all of our lives depend: nuclear reactions in the Sun. Now those graduates have heard about the quantum nature of the world we live in.

## **PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES**

- **Student Data and Longitudinal Tracking:** Total awards = 42. Fellowship/Scholarship = 22 (13 undergrads, 9 grads), including 2 grads in Higher Education/Research Infrastructure. Summer research awards = 20. Of the 42 awards, 31% were made to females, and 10% to African-Americans. During the FY11 program year, 4 of the awardees are pursuing advanced degrees in STEM disciplines, 1 accepted a STEM position at a NASA contractor, 9 accepted STEM positions in industry, 5 accepted STEM positions in academia, and 3 went on to positions in non-STEM disciplines. The remaining students have not yet received the degree that they were pursuing when they received their Space Grant award.
- **Diversity:** Delaware State University enrollment is 62% female and 73% African-American. Wesley College enrollment is 56% female and 29% African-American. Delaware Technical and Community College (DTCC) enrollment is 61% female and 24% African-American non-Hispanic students. Wilmington University enrollment is 65% female and 18% African-American. During FY11, 31% of the students receiving support from DESGC were female and 10% were African-American.
- **Minority-Serving Institutions:** Delaware's MSI, Delaware State University, is an active affiliate of DESGC. DESGC has active contacts with one faculty member on each of the four campuses of DTCC, and these contacts have resulted in applications being submitted for undergraduate tuition scholarships.
- **NASA Education Priorities:** Hands-on student experiences by our DTCC (Terry) students broke new ground this year when Dr. Lester Link and two of his students attended the Academic High Altitude Conference at Iowa State University.

Dr. Stephanie Wright in FY11 continued to offer her Professional Development opportunities for middle school teachers to provide them with NASA materials for their classrooms: including constructing their own Galileoscope (Feb. 23), attending the GSFC forum for teachers (March 17), National Air and Space Museum (March 19), Earth Systems workshop (May 16), the SunWise program workshop (Oct. 7).

Summer opportunity for high-school students: two students from Wilmington Charter High School (Jay Yadav, Ryan McGeehan) worked with DESGC Associate Director William H. Matthaeus learning how to apply Fourier analysis techniques to space-craft data.

Community college contacts in DE are now well-established in the DESGC network: Director Mullan has personally visited all four campuses of DTCC and is in active contact with the affiliate rep on each campus. These contacts ensure that DTCC students have easy access to DESGC funds: we will set a new record in summer 2012 for summer interns, with three of the awardees being from DTCC.

Research Infrastructure Development funds were supplied by DESGC in FY11 to early career faculty member Dr. Chereese Winstead to support her work on nanoparticle research at Delaware's HBCU (Del State U). Those RID funds, in addition to DESGC/RID funds awarded to Dr. Melikechi in his Applied Optics Lab at Del State in previous years, enable the training of students in high-tech STEM skills, as the NASA priorities demand.

## **IMPROVEMENTS MADE IN THE PAST YEAR**

The major changes in resource allocation were made by DESGC in FY11 include the following.

- (i) A new program coordinator (Ms. Cathy Cathell) was hired to replace the previous coordinator who moved to another position. Ms. Cathell's formal start date was March 1, 2012, the day on which the National SG Directors' meeting opened in Crystal City, VA: Ms. Cathell attended that meeting, and had a chance to meet many SG folks from across the country.
- (ii) Awarding the largest amount ever awarded to our HBCU (Del State University) for RID funding to a new Assistant Professor (Dr. Chereese Winstead; African-American female). An especially valuable aspect of the award was that Del State charged zero percent overhead, thanks to the Dean (Dr. Nouredine Melikechi), who is DESGC Affiliate Rep at Del State. Thus, Dr. Winstead was able to get maximum returns from her DESGC RID funding.
- (iii) An unusually large number (20) of students funded by DESGC to do summer research. This was possible as a result of leveraging of funds with some faculty members in two different departments at UD, as well as remaining funds from previous year NASA support through ESMD.
- (iv) The largest number of DE students ever funded by DESGC to do summer research internships at NASA centers: three DE students were funded in FY11, one each at GSFC, JSC, and ARC.
- (v) Increased funding of graduate fellows, raising the stipend to \$26,000, which is higher than DESGC has ever awarded in the past: this led to an upsurge in the number of applications for DESGC-funded graduate fellowships, and to an increase in the severity of the competition for those fellowships.
- (vi) The DESGC Annual Research Symposium was held on April 27, 2012 in a centrally located conference room on UD's Newark campus and was open to the community. It

was attended by 50+ students and faculty, who heard a keynote speaker from ILC Dover talk about the continuous and high-profile role that Delaware industry has played in NASA efforts over the past 50 years: 2012 is the 50<sup>th</sup> anniversary of the first ILC contract to make space suits for NASA. The diversity of the DESGC program was much in evidence at the Annual Symposium: among the eight oral presentations, five were given by women, of whom two were African-American. Moreover, two speakers were Asian-American, and two of the speakers were students at Delaware's HBCU (Delaware State University), funded by DESGC/RID support to Assistant Professor Dr. Chereese Winstead.

## **PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION**

(1) 4-year academic institutions:

(a) The lead institution of DESGC is the University of Delaware [UD]. UD is classified by the Carnegie Foundation for the Advancement of Teaching as a research university with very high research activity, a designation accorded to fewer than three percent of the more than 4,200 degree-granting institutions in the USA. Currently, UD has 17,000 undergrads and 3,600 grad students enrolled, and offers bachelor degrees in all STEM-G subject areas. Most of the DESGC graduate fellows are UD students from a variety of colleges: Arts & Sciences (Departments of Physics/Astronomy, Chemistry, and Geography), Engineering (Departments of Mechanical and Chemical & Biomedical), and Marine Studies. UD undergraduates from a variety of colleges have benefitted from DESGC-funded tuition scholarships and summer research opportunities. Researchers in various colleges (Engineering, Earth, Ocean & Environment, Arts & Sciences) have benefitted since 2005 from DESGC Research Infrastructure Funds.

(b) Delaware State University [DSU], an MSI, has 3,700 undergrads, 400 grad students, and offers bachelor degrees in at least one STEM-G area. The student body is 73% African-American non-Hispanic. One of the FY11 DESGC grad fellows is a DSU student (Ms. Kimberly Milligan). In FY11, DSU faculty member Dr. Chereese Winstead was the recipient of a DESGC/RID award for her nanoscale fabrication lab. Two DSU undergrads were awarded DESGC tuition scholarships in FY11, and one undergrad at DSU was supported in part by some of Dr. Winstead's DESGC/RID funding.

(c) Wilmington University [8,838 undergrads, 5,457 grads] offers a range of bachelor degrees which includes one or more of the STEM-G disciplines. In FY11, three WU undergrads were recipients of DESGC tuition scholarships.

(d) Wesley College [2,500 undergrads] offers a range of bachelor degrees in the STEM-G disciplines. 37 percent of the student body are African-American, and 42 percent are female. In FY11, DESGC supported three undergrads (including one female, one Hispanic) with tuition scholarships. A noteworthy aspect of these undergrads is that, although not directly funded by DESGC for research, two of them attended the DESGC Annual Research Symposium (April 27, 2012) and presented posters on research which they performed under other auspices: the Wesley campus culture (embodied in DESGC

affiliate representative Dr. Malcolm DeSouza) encourages students to be keen about communicating their research to their peers.

(e) For the first time in FY11, DESGC provided undergrad tuition scholarships to two students attending Goldey-Beacom College, the latest four-year college in DE to become a DESGC affiliate. GBC has 1,600 students, mostly in Business subjects, but with majors in Computer Information Systems, thereby providing an overlap with STEM subjects.

(f) Villanova University, a DESGC affiliate in the southeastern corner of PA, provided DESGC-sponsored summer research opportunities for 4 students in physics/astronomy in FY11.

## (2) 2-year Academic Institution

Delaware Technical and Community College (DTCC), has a total of 15,000 students on four campuses distributed widely across the State. The student body includes 24 percent African-American non-Hispanic. In FY11, zero DTCC students applied for DESGC-funded tuition scholarships: this is due in part to a generous program from the state government which pays full tuition at DTCC for two years to any student who graduates from a DE school with a GPA of 2.5 or better.

(3) Delaware AeroSpace Education Foundation (DASEF) is an enterprise founded in 1989 by Dr. Stephanie Wright (at one time, Delaware's Teacher in Space) to create an exceptional learning environment that inspires children and their families with an appreciation of the Earth and its place in the universe. DASEF has contributed to the academic development of over 300,000 students, educators, and the general public through the delivery of context-based activities consistent with current aerospace research and development.

(4) Industrial affiliates: ILC Dover (makers of space suits for NASA), E.I. DuPont de Nemours, and ATK (Thiokol) Elkton supply active members to DESGC's Advisory Board. Activities of these board members include reviewing applications for DESGC Graduate Fellowships and providing a detailed statistical analysis of the results to ensure a lack of bias among reviewers.

\*\*\*\*\*

Sum total of plusses and minuses: How well did DESGC do in achieving the metrics which were proposed in the FY11 proposal? Here are our results, as listed above.

Number of +: 29  
Number of -: 7  
Percentage of +: 81%

\*\*\*\*\*

Respectfully submitted,

Dermott J. Mullan  
Director, Delaware Space Grant Program  
203 Sharp Laboratory, 104 The Green  
University of Delaware, Newark, DE 19716  
(302) 831-2170  
[mullan@udel.edu](mailto:mullan@udel.edu)

## **Delaware Space Grant Consortium**

### **Justification for revised FY12 budget**

The following Changes have occurred between what was submitted in 2010 as the (estimated) 3<sup>rd</sup> year of the 5-year project and the current proposal for FY12.

Salary support for Director: reduced by \$1.4K. Matching funds from UD for Prof. B. A. Williams, originally estimated to be \$22.4K, are now zero in FY12: Prof. Williams has chosen to retire from UD as of June 2012. Requisite matching funds had been well in excess of the minimum required by NASA: so even with this alteration, DESGC is still able to provide the necessary match.

Salary support for Program Coordinator (PC): increased by \$4K over the FY10 Year 3 estimate. The reason for the increase is that the newly hired PC (Ms. Cathell) came from another Department on UD campus where her salary was higher than the previous PC. The HR Office at UD insisted that when DESGC hired Ms. Cathell, her salary was to remain at her previous level. However, the increase in the line item in the revised FY12 budget is not as large as it will be next year (when we submit for FY13) for the following reason: in FY12, we will take advantage of unspent funds carried over from FY11. When the previous PC resigned, the search for replacement took 2.5 months because of requirements imposed by HR/Affirmative Action. With the post being vacant between 12/15/2011 and 3/1/2012, there are unspent funds in the amount of \$5K in the line item for PC at the end of the FY11 budget. Carrying that amount over into FY12, we are able to keep our line-item for PC funding in FY12 smaller than it would otherwise be.

Number of graduate Fellowships: reduced in number from 4.5 to 3.5, but increased in value for each full-year stipend award from \$24K to \$27K. The increase allows DESGC to offer fellowships to graduate students which are \$1K larger than the average amount awarded by the Department of Physics/Astronomy at UD to their TAs.

Academic-year funding for the Graduate student in Geography Education is increased by 0.5K to allow for cost of living increases.

Undergraduate Tuition scholarships: reduced from 10 to 9 in order to free up funds for a new initiative for Community College students (who have just been awarded time on Reduced Gravity mission). As well as a reduction in numbers, the split between categories changed to allow for more student support at DE's 2-year community college (DTCC).

Note: combined Fellowship/Scholarship amounts total \$137K, which is in excess of the minimum amount (\$110K) specified by NASA

Summer research: changed, with an increase of \$6.25K to allow us to offer one more line of support for DE students to work at a NASA center. But we retain the 5 REU slots for students interning on their local campus: this is the same number as was listed in the original out-year budget.

Research Infrastructure: changed, with a decrease of \$10K. Originally, a total of \$40K was assigned to fund two programs, one at UD Marine Studies, and the other for Precision Farming. In the revised version, we propose to use \$30K in order to support the Astrobiology research of Dr. Chandran Subanayagam, formerly an Assistant Professor at our HBCU (Del State Univ) but now at the Delaware Biotechnology Institute (DBI) in Newark, DE. Dr. Subanayagam proposes to work on the following research:

***“Development of liquid and gas microfluidics devices for remote astrobiology applications”***

PI: Chandran R. Sabanayagam, Ph.D. (Delaware Biotechnology Institute, Newark, DE)

**Project Summary**

The goal of this project is to develop microfluidic devices to process liquid and gas samples for remote astrobiology missions. Specifically, the microfluidic devices will be used on missions of opportunity to address NASA’s fundamental questions: how does life begin and evolve, and does life exist elsewhere in the universe? The developed microfluidic devices will be capable of remote *in situ* sample collection and processing. These devices can also be used to monitor the survival and adaptation of Earth’s microorganisms beyond our planet, for example during Low Earth Orbit satellites to study the effects of gravity unloading. Samples inside the devices will be analyzed using optical techniques such as: laser scanning confocal microscopy, total internal reflection microscopy, fluorescence correlation spectroscopy, fluorescence lifetime analysis, and scattering/absorption/luminescence spectroscopy. These optical techniques are widely used to characterize biomolecules on Earth, and have great potential to probe the universe for evidence of extant or extinct life, and to monitor the survival and adaptation of Earth’s microorganisms in extraterrestrial environments. The devices will be optimized for integration with optical instruments that have small form factors to be utilized in remote systems such as micro- and nano-satellites, planetary rovers and landers. This project is relevant to the NASA 2008 Astrobiology Roadmap Goal 2 (Objective 2.1—Mars exploration; Objective 2.2—Outer Solar System exploration), Goal 3 (Objective 3.1—Sources of prebiotic materials and catalysts), Goal 6 (Objective 6.2—Adaptation and evolution of life beyond Earth) and Goal 7 (Objective 7.1—Biosignatures to be sought in Solar System materials; Objective 7.2—Biosignatures to be sought in nearby planetary systems).

The microfluidic devices will be fabricated based on the well-known technique of polydimethylsiloxane (PDMS) soft lithography. Tens to hundreds of independent or interconnected channels can be accommodated in a four to six inch diameter substrate. These channels will be approximately 50-500 microns wide, by 50-100 microns in height. Gas and liquids can be delivered to the microfluidic device by miniature diaphragm pumps. Also, recent advances in microfluidics have enabled the use of multi-layered PDMS channels to make valves—a series of three closely-spaced valves has been used to make a PDMS peristaltic pump to move fluids throughout the device. This project will explore both methods for fluid transport. Additionally, we will design temperature controls to maintain the device at a constant temperature, or to cycle between different



temperatures. It is known that reduced temperatures (~ 4° C) slow down the metabolism of many organisms, and in particular, nematodes become immobilized which will allow high resolution optical imaging of the animal. Animal immobilization is easily reversed by increasing the temperature. We will explore two methods for temperature control, thermo-electric heating/cooling and resistive heating. As proof-of-concept, we will fabricate miniature “life-support” microfluidic devices for two different microorganisms, bacteria and nematodes. The microfluidic devices will deliver nutrients, and sort the specimens into separate isolated compartments for microscope analysis. The main objective of this research is to maintain the model microorganisms for months inside the microfluidic devices in an automated manner. The end device can be potentially used to study the effects of gravity unloading onboard Low Earth Orbit satellites.

### **Budget**

\$1,545	Xavitech gas micropumps (10 units) plus flow calibration unit
\$3,396	MTI Corporation vacuum chuck spin coater for 8” wafers
\$6,299	Harrick Plasma cleaner with oxygen compatible vacuum pump
\$4,800	NuArc 1000W Metal Halide exposure system
\$1,255	Fisher Scientific Isotemp laboratory oven
\$3,097	VC-8M multi-valve perfusion system
\$568	Perfusion pressure kit for VC-8M
\$968	Thorlabs temperature controller
\$500	Various resistive heaters, thermoelectric elements, thermocouplers
\$1,000	Indium-titanium oxide coated quartz substrates
\$3,555	4”x4” photomasks (10 custom masks from Photo Sciences, Inc.)
\$3,000	Consumables: photoresist (SU-8), developer, tubing, biochemicals
-----	
\$29,983	

Travel: travel costs to two national meetings plus one regional meeting reduced from \$7.1K to \$6.5.

Annual Research Symposium costs: not in original budget, but experience has shown that rental of room on UD campus plus equipment plus lunch expenses lead to costs close to \$1K. This is a new item in FY12 budget.

National Space Grant Foundation (NSGF): new items are now included (\$7K) to cover our costs of contracting with NSGF for Longitudinal Tracking and On-Line Applications. These items were not mentioned at all in the FY10 budget: we had to take funds out of overhead return to pay for those items in FY10.

### **Teacher Training/Higher Education:**

(i) *DTCC-Reduced Gravity Event:* in FY12, we propose to add an entirely new line item (\$5.5K) for a team of 8 students at Delaware’s 2-year community college (DTCC) campus in Stanton DE: the team, headed by student Robin Depto (a previous awardee of a DESGC Tuition Scholarship) has been awarded time on a Reduced Gravity Event

(RGE) on a plane which flies on a series of parabolic arcs over the Gulf of Mexico. This is the first time that anyone from DE has participated in the RGE: DESGC proposes to fund one-half of the costs for the team to fly to Johnson Space Center and participate. Here is the cover page of their proposal, plus budget justification provided by team leader Depto:

Title of Experiment: Vertical Projectile Motion with Drag in 1-g and 0-g Environments  
 Topic Area: Projectile Motion  
 Team Name: Delaware Technical & Community College  
 Academic Institution: Delaware Technical & Community College  
 Stanton Campus  
 400 Stanton-Christiana Rd.  
 Newark, DE 19713-2197  
 Team Contact: Robin Depto (rdepto@dtcc.edu)  
 Faculty Supervisors: Michael Cimosori  
 (mgcimosori@verizon.net)  
 Navarun Jagatpal  
 (navarun.jagatpal@gmail.com)

Team Members:

Budynkiewicz, Samantha (sbudynki@dtcc.edu). Alternate Flyer / Junior / Nursing  
 Depto, Robin (rdepto@dtcc.edu). Flyer / Sophomore / Comp. Info Sys  
 Hassan, Muhammad (mhassan1@dtcc.edu). Flyer / Sophomore / Electronics  
 Hsu, Wilson (whsu@dtcc.edu). Ground Crew / Freshman / Computer Network Engr  
 Kokoszka, Catherine (kkokosz1@dtcc.edu). Flyer / Junior / Physical Therapy Asst  
 Szczubelek, Jeffrey (jeffrey6@gmail.com). Ground Crew/ Sophomore/Mid. Sch. Math  
 Van Nostrand, Scott (svannost@dtcc.edu). Flyer / Sophomore / Computer Network Engr  
 Zelaya, Diego (dzelaya@dtcc.edu). Flyer / Sophomore / Math Secondary Education

FUNDING/ BUDGET STATEMENT

Air Travel	\$4,113.00
Van Rental	\$854.99
Hotel	\$4,905.00
Food	\$1,620.00
Launcher & Accessories	On Loan
Tubes (2)	\$440.00
Electronics	Donated
Laser System	On Loan
Shipping	<u>\$44.60</u>
TOTAL	\$11,977.59

DESGC offers roughly one-half support for the expenses. The team is also seeking funding from DTCC, DASEF, local corporations, and National Community College Aerospace Scholars.

(ii) *DTCC-Pathevo* activities are reduced from \$8K to \$3.98K. The original budget had planned to purchase career software (Pathevo) for DTCC students: the purchases were

made in FY11, so in FY12 there is a change in the approach to this program. In line with DE Governor Markell's plans for STEM education in the state, Dr. Doug Hicks, Chair of Engineering technologies at the Georgetown, DE campus of DTCC, plans to have a state-wide meeting of high-school STEM teachers so that they can learn how to use Pathevo for career guidance for their students. Here is a justification of Dr. Hicks' proposal:

### **Engineering and Engineering Technology Career Workshop for High School Technology Teachers**

**Proposal:** Develop and conduct a workshop fall 2012 for all Delaware's High School technology teachers to provide them with current information on educational and career pathways in engineering and engineering technology. The workshop would be jointly sponsored by the Univ. of Delaware's College of Engineering (Dr. Michael Vaughn at the College of Engineering has been contacted and has expressed interest in being involved) and the Engineering Technologies Departments at Delaware Technical Community College's three campuses. It would be held mid-State at the DTCC Terry Campus for easy access (DTCC will provide the meeting space for free) with the following general format:

- mid-fall
- all high school technology teachers (approximately 50)
- all-day (9:00 – 3:00)
- lunch provided so they can stay together to network
- DE Dept. of Ed. provides CEU's to enable the teachers to obtain leave and professional development
- 1-3 speakers with strong practical, working knowledge of the subject
- demo any of the teaching resources we are suggesting they use such as Pathevo, Career Cornerstone, other

**Rational:** The workshop will provide current, detailed information and resources to enable the high school technology teachers to better advise students regarding pathways in engineering and engineering technology. To be successful will require finding presenters that are very credible to the audience, understand the environment the teachers work in, and can provide them with useful tools for conveying the career information to their students.

Much of the effective work for STEM recruiting needs to be at the "grass-roots" level. This type of focused workshop would help the high school technology teachers become more knowledgeable and effective as STEM recruiters. With the extensive daily interactions they have with the students, they can play a big part in getting accurate information to a large and receptive audience. They can also help convey the appeal careers in engineering and engineering technology have to young people if they are given a broader perspective through activities like the workshop. The workshop could also help form STEM linkages within the PK-20 system, one of the STEM Council's objectives. The workshop model would be based on two previous successful workshops organized by DTCC to help high school technology teachers change from 2-D computer aided design software (CAD) to parametric modeling and BIM software. The proposed

workshop would serve as a model for similar activities to foster career awareness in all STEM pathways and is consistent with the objectives of the Governor's STEM Council.

**Budget:**

Planning and organization: Doug Hicks 32 hours @ \$50/hour = \$1,600

Lunch for attendees: 60 participants, presenters, and guests @ \$12 each = \$780

Speakers (travel and honoraria): 2 @ \$800 = \$1,600

Meeting room: provided by DTCC no charge

Total: \$3980